



Potassium persulfate promoted catalytic wet oxidation of fulvic acid as a model organic compound in landfill leachate with activated carbon

Xi-Yan Xu, Guang-Ming Zeng^{*}, Yan-Rong Peng^{*}, Zhuo Zeng

College of Environmental Science and Engineering, Hunan University, Changsha 410082, PR China

Key Laboratory of Environmental Biology and Pollution Control, Hunan University, Ministry of Education, Changsha 410082, PR China

HIGHLIGHTS

- ▶ A promising route for degradation of fulvic acid is reported.
- ▶ Fulvic acid and its COD are efficiently removed.
- ▶ Biodegradability of fulvic acid is greatly increased.
- ▶ Activated carbon exhibits good stability in the system.
- ▶ Radical mechanism is studied in detail.

ARTICLE INFO

Article history:

Received 15 January 2012

Received in revised form 9 May 2012

Accepted 9 June 2012

Available online 17 June 2012

Keywords:

Catalytic wet air oxidation

Active carbon

Potassium persulfate

Fulvic acid

Landfill leachate

ABSTRACT

Fulvic acid (FA) is known to be present at high concentration in leachates from “mature” and “old” landfills. In this work, the catalytic wet air oxidation (CWAO) of FA as a model of refractory organics of stabilized leachate was studied with activated carbon (AC) as catalyst and potassium persulfate ($K_2S_2O_8$) as promoter. The effect of temperature and the amount of AC and $K_2S_2O_8$ on the degradation of FA were investigated. Results revealed that FA could be efficiently degraded in the $K_2S_2O_8$ /AC system. At 150 °C and 0.5 MPa oxygen pressure, almost complete FA conversion and 77.8% COD removal were achieved after 4 h of treatment. The biodegradability of BOD₅/COD ratio increased from 0.13 of raw FA solution to 0.95 after CWAO. AC exhibited good stability in the catalytic wet oxidation of FA. When AC was used for the fourth time, the FA conversion was still over 60%. Additionally, radical mechanism was studied and three radical scavengers (methanol, *tert*-butyl alcohol, sodium bromide) were used to determine the kind of major active species taking part in the degradation of FA. It was assumed that hydroxyl radical ($\cdot OH$) and sulfate radical ($SO_4^{\cdot -}$) played a major role in the FA degradation.

© 2012 Elsevier B.V. All rights reserved.

1. Introduction

Landfilling continues to be the most attractive method to cope with the municipal solid waste [1–5]. The component of landfill leachate, well known for its high concentration of refractory organics and heavy metals [6], varies according to different landfill age (young, intermediate and stabilized). Fulvic acid (FA) is one of main refractory organics existing in the stabilized landfill leachate [7–11]. There are significant numbers of hydroxybenzene, ethylate, carboxyl and chromophore in FA [10]. Thus, when existing in water, FA can affect its sense and taste, and produce high value of Chemical Oxygen Demand (COD) in liquid [12]. Moreover,

chemical reactions may occur between FA and disinfectant of tap water to generate disinfection byproducts (DBPs) which were proved to be carcinogenic [13].

Since the landfill leachate could jeopardize the aquatic system directly or indirectly, it should be properly treated to remove the organics based on COD and Biochemical Oxygen Demand (BOD) before introduced into a sewage system [14,15]. Biological treatment is one of the most common ways for the treatment of landfill leachate [16]. However, biological processes are usually inefficient for the treatment of the refractory compounds (mainly humic substances) in landfill leachate [15]. As a consequence, alternative technologies have been developed to remove the refractory compounds as pretreatment or post-treatment stage. In the past decades, several methods have been developed to treat landfill leachate, such as physical adsorption [17,18], photochemistry [14,19], electrochemistry [20] and catalytic wet air oxidation (CWAO) [10,21].

^{*} Corresponding authors at: College of Environmental Science and Engineering, Hunan University, Changsha 410082, PR China. Tel.: +86 731 8 8822754; fax: +86 731 8 8823701.

E-mail addresses: zgming@hnu.edu.cn (G.-M. Zeng), pengyr@hnu.edu.cn (Y.-R. Peng).